

# THE PROCEEDINGS *of* THE INSTITUTION OF PRODUCTION ENGINEERS

*The Official Journal of the Institution of Production Engineers*

Members are requested to correspond with the Editor upon matters of general interest. Letters may take the form of descriptions of unusual plant or tools, workshop methods, production problems or organisation systems. Only in exceptional circumstances will proprietary articles be dealt with editorially. Manufacturers wishing to draw the attention of the Institution to the merits of their products are invited to use the advertisement columns of this Journal. All correspondence should be addressed to the General Secretary, Institution of Production Engineers, 48, Rupert Street, London, W.I.

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## MANAGEMENT AND MORE WORK IN LESS TIME.

Paper presented to the International Management Congress, Paris, June, 1929, by A. Perry-Keene (Member).

THE words "British Made" imply goods of outstanding quality. How can these be made at a sufficiently cheap selling price to attract purchasers in large numbers and so secure a quantity market? The British Empire controls or possesses areas of the world which tend to put it in a unique position with regard to supplies necessary for the support of intensive manufacturing projects.

England itself is without question well situated for development of such schemes. Factories are comparatively close together, transport distances are favourable, labour is competent and there is a sufficiency. Such being the case, why is it that British goods do not command a greater quantity sale, both at home and abroad? The answer is simple. The cost of production and, consequently, the list price is too high to ensure a free market. Conditions have changed somewhat abruptly since the close of the Great War, whereas up to 1914 the tendency was to manufacture and sell

comparatively few articles at a high price, now owing to, amongst other things, a generally greater distribution of earnings upon a higher scale, the demand is definitely in the direction of comparatively large quantities at moderate prices. The present average standard of living calls for numerous amenities, not contemplated or expected before the late war, but to ensure free sales, the goods involved must be both cheap and of unimpeachable quality. Since Great Britain possesses supplies, factories and plenty of skilled and unskilled labour, what is the factor militating against maximum extension of all markets? Why can other nations successfully encroach upon these so long commanded by her? Scarcely upon quality, therefore it must be upon price. Have we sufficiently studied the broad elements of economies in relation to time? For generations we have been aware of the adage "Time is Money" but do we really recognise it? If employer and employed could view their problems from the angle of "Time Saved" many of their interests would be found to rest upon a common basis and a solution of most present difficulties would be in sight.

How shall we awaken the workers' interest in the problem of cheap production? The old time method of cutting wages is threadbare—the only solution is, therefore, higher output accompanied by higher earnings for the workers. Economics dictate the fact that although "High Wages" have no meaning and may quickly lead to bankruptcy, "High Earnings," that is money earned in direct relation to output, open up possibilities in the way of increased pay which do not appear to have been sufficiently studied. Extra effort on the part of the worker can be suitably and proportionately rewarded.

Presuming the production force of an undertaking is remunerated upon the quantity of output which it is its duty to produce, quality being fully considered and insisted upon and the selling force upon the amount of turnover reached, diverse interests fall mutually into line and maximum effort is forthcoming. This method is psychologically sound and is a counterblast to the older one which undoubtedly evolved a spirit of repression and led to retaliation on the part of labour, lower output and high costs of production, consequently a limited market.

More work in less time is obviously our economic problem of the moment. How shall we accomplish it? As practice is always of interest when compared with theories set up, I will recount the progress made by a large British firm which recognised the possibilities of "Time Saved" if applied to a modern manufacturing concern. Progressively successful, the methods have led to a most remarkable recovery to prosperity, although starting against a load of debt and difficulties.

Time in minutes or fractions thereof is the prevailing factor in all layouts and calculations, and time saved is the basis upon which

individual labour of any grade can increase its earnings. Recognition of extra effort is promptly expressed in the next forthcoming pay packet.

The "Normal Time" basis is set up in the planning department and discloses an allowance in minutes for the contemplated operation. All work as planned is demonstrated upon the actual machine that is to be used. This discloses the time likely to be taken by an average operator. This time is fixed and the worker is allowed and encouraged to save as much as possible by becoming expert and is paid the whole of the time saved by way of bonus. This practice gives an opportunity for both mental and physical capacity to come into play. Not only in actually accomplishing the job but in making local preparation for loading and unloading the jigs, etc., and handling supplies into the machine so that there is a minimum interruption to flow. Obviously it is to the benefit of both employer and employed to use each item of plant to its ultimate capacity, the worker receiving remuneration upon time saved and the company on cost saved, the one in exchange for extra effort forthcoming and the other in providing the facilities and organisation whereby the work becomes possible. Thus is obtained—higher earnings for the worker—more profits whereby to stabilise and expand the undertaking—together with greatly reduced list prices for the consumer. This may be illustrated by the following statistical record covering the period during which the scheme has been in vogue.

	<i>Per cent.</i>
Increase in turnover	... 611
Increase (average) in workers output efficiency	} 79
Increase in individual earnings	...
Increase in profits	... 328
Decrease in cost to purchasers due to lowered list prices and added equipment	... 62
Expansion in export	... 430

Thus has been created a market that did not previously exist. The very material lowering of price accompanied by increase of intrinsic value bringing the products within reach of purchasers who did not previously expect to obtain such quality at so low a price and were not in effect catered for with products moderate in first cost and sufficiently cheap in upkeep to make their extended use a positive economy. This policy automatically creates that great desideratum for a nation of manufacturers—consumption of products on a large scale.

An analysis of such methods shows the following main features.

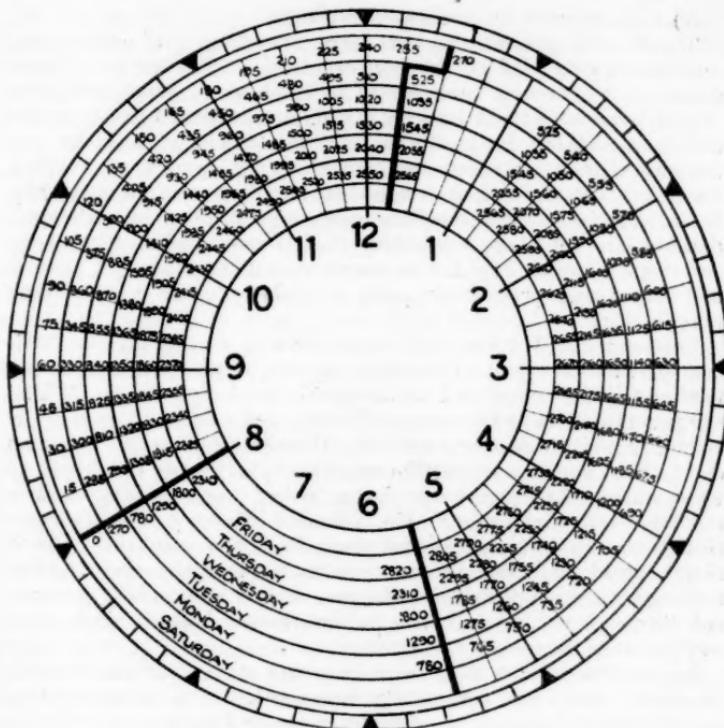
- (a) Time in minutes is the basis of all calculations and operations relating to production.
- (b) Basic time allowances are positively fixed and guaranteed to the workers, and any time saved is credited to their

- account for payments. Maximum pressure is used to see that in each individual case the earnings are high.
- (c) Definite planning is resorted to in the case of each and every operation, nothing is left to chance, planning covering the whole range of operations and movements from rough material to saleable products.
  - (d) With a view to creating confidence and enthusiasm, maximum earnings are encouraged and expected. The effect of large output and lower incident on oncost is explained to all and sundry, and is understood and appreciated.
  - (e) A daily efficiency account is in operation against each worker and machine, so that results can be continually measured and immediate steps taken to correct any retrograde movement which can be instantly observed and located to—
    - (1) Executive or supervision faults.
    - (2) Bad material.
    - (3) Unsuitable equipment facilities.
    - (4) Unsuitable operator.
  - (f) Both working and commercial elements have a direct and immediate interest in the progressive success of the undertaking, poor performance being promptly followed by small remuneration and large output and sales by a proportionate increase of pay.

In actual practice the following methods are pursued.

- (1) A manufacturing programme is laid out covering periods which, after close scrutiny, prove to be convenient having regard to the possibility offered by the world's market for any one complete season.
- (2) Each period is resolved into terms of turnover, which upon analysis discloses, amongst others, the following particulars—
  - (1) The expected load upon the plant and process facilities.
  - (2) The number of employees necessary to carry out the scheme.
  - (3) The volume of purchases required.
  - (4) The quantity of products per minute or hour which must be delivered from each machine or section.
  - (5) The expected cost of production in view of the layout employed and the quantity to be handled. This cost includes both shop and financial charges.

Speedy accounting is necessary constantly to follow the cost of operation and movement of material within the works. To this end, three batteries of Power's mechanical analysing machines are employed, two sets being reserved for material and one for analysing both quantities and value. Extensions are checked upon a



battery of electrical calculating machines. Speed of operation with this equipment is very great and it is possible to analyse all happenings so that any necessary information is immediately to hand and can be made of active use in preventing the development of faulty procedure which might lead to high cost. At the same time the confidence resulting from knowledge as to how current work is proceeding practically hour by hour enables large quantities to be passed through the works without waiting for "trial and error" tests.

To expedite calculations, terms are resolved as follows.

- (a) All time is in minutes or fractions thereof. Example : Forty-seven hours is looked upon as 2,820 minutes, as shown on the accompanying blue print of a time calculating clock used in the works. The six concentric rings show the available minutes in each day.
- (b) £ s. d. to fractions of a penny per minute. Example, .1660 pence equals 39s. per forty-seven hours.

(c) All weights to pounds or fractions.

These arrangements enable the analysing and calculating machines to be used to the best advantage. Labour is analysed direct on to Power's cards so as to produce at once continuous comparison, whilst material is taken on charge at the receiving decks on suitably designed Powers' cards whereby payment may be immediately franked and initial stores quantities verified. Therefore, a Powers' plant designed for handling material constantly deals with issues and resulting quantities flowing into the production line. A night accounting staff is employed so that at the end of each twenty-four hours a master card shows the net amount of finished and progressive parts available for the coming day's manufacture.

Labour is divided into various grades each having its own basic rate of remuneration. Operation layouts stipulate which classifications shall be employed for the particular work in hand. Whilst the programme is in execution, efficiency and output of each grade of labour is continuously surveyed. Unless a bonus approximating eighty per cent. is earned, the employee's service is not likely to be retained, that percentage being looked upon as disclosing a minimum rate of efficiency. The collective efficiency of each section is also continuously scrutinised both from the point of view of basic output and also the same with its inclusive result, after bearing all shop and financial charges. If any section fails to carry out its proportionate task this is immediately known, when steps can be taken to rectify the matter.

Jigs and tools have to be kept in a high state of efficiency, consequently they are continually inspected by a perambulating section, whose duty it is to pass out to the tool room anything that tends to fail to reach the required standard of accuracy. Plant is dealt with in much the same manner, any units which cannot be dealt with locally being removed to the tool room for complete overhaul. The main principles employed in production output are applied to the tool room, times being allowed for each job and the worker paid additional remuneration for savings made. This has resulted in a saving of approximately twenty-nine per cent.

The plant in use is not by any means of the one-purpose type, as changes of design are frequent. To maintain the correct balance of output, the worker is not necessarily employed on the same job or product all the time, but when the correct quota is reached is moved on to some other work for which a job ticket, tools and facilities are ready, therefore waste time is eliminated.

Where batteries of the same type of plant are employed one or more spare machines are kept ready to replace any which may require repair.

Since the system has been in use, a remarkable drop in the cost of broken tools and also scrap material has resulted, thirty-seven

per cent. and thirty-four per cent. respectively. This is satisfactory to employer and employed alike, their interests in this direction obviously being mutual and affecting the pockets of both.

The results that are described above have been attained upon a quantity production basis market. What about the "single entity" type of manufactory, making such things as one large marine engine, half a dozen locomotives of a special type, and so on? Provided the turnover in sight and the number of man-hours contained therein are large enough to remove the complete line of operation from the realms of experiment, there is the opportunity of creating a spirit of confidence and helpfulness amongst the workers, if thoroughly capable planning is in evidence, so that saving of time can fructify to the fullest extent.

What is the price of operating such a scheme? In the above case, the whole executive side of production, planning, buying, costing, making up and payment of wages, and also of necessary drawings for jigs, tools and smaller parts, costs an average of considerably less than 10s. per £100 of net sales. An insignificant figure but an illustration of how, if increased and sufficient production is attained, volume of oncost need never be feared, as the incident is low and cost per piece is greatly reduced.

We hear of many discussions as to the standing of both capital and labour but do we give sufficient study to the third factor which must help to build up the success of any undertaking—management? However good the possibilities and general equipment of a concern may be it is foredoomed to mediocre performance or complete failure if management is not very much alive and capable of grasping its opportunities as they occur. Modern accounting methods can be made to meet the requirements of to-day's practice where the tendency is for a great range of trades and departments to be concentrated under one roof. Imagine the confidence forthcoming from a complete and accurate view of the inter-trading relations of each section where it can be positively and promptly shown that although a profit to the concern may be made, yet certain sections are not contributing their fair share.

Such knowledge points the way to improvement. Management has the opportunity to use it. This is merely one example amongst many. Realise that time and conditions are greatly changed even when compared with ten years ago. Now is the opportunity for management to assert itself and by studying and intelligently using modern methods and ideas to lead on to development and success.

## **REGULATIONS FOR THE AFFILIATION TO THE INSTITUTION OF ENGINEERING ASSOCIATIONS.**

1. With a view to establishing a connecting link between Engineering Associations throughout the country concerned with Engineering Production Problems, the Council of the Institution of Production Engineers is prepared to receive application from such Associations for Affiliation to the Institution.
2. Only Associations whose main object is the discussion of questions dealing with Engineering will be affiliated under this scheme. The Council reserves the right to cancel at any time, or not to renew, the Affiliation of any Association.
3. Application for Affiliation should be made on the prescribed Form by an Officer of the Association authorised to do so.
4. The annual affiliation fee to be paid by each Affiliated Association is £1 1s. 0d. for each fifty members or part thereof, payable on affiliation and, thereafter, on the 1st July in each year.
5. The Institution will, if so desired, give Affiliated Associations its co-operation in the preparation of their Sessional Programmes, and will supply to the President and Secretary of each Affiliated Association a copy of **THE JOURNAL** and **THE BULLETIN** of the Institution, together with the Syllabus of its Sessional Programme.
6. Affiliated Associations shall have a right to select for reading and discussion Papers published in **THE JOURNAL** of the Institution such Papers to remain the copyright of the Institution and only to be published elsewhere than in **THE JOURNAL** with its permission.
7. Members of the Institution will be encouraged to lend their services by reading Papers before Affiliated Associations on suitable arrangements regarding expenses being made, where necessary.
8. While affiliation will not entitle members of an Affiliated Association to Membership of the Institution, or confer on them any rights or privileges of Membership, Local Section Committees of the Institution are empowered, at their discretion, to supply to the President or Secretary of any Affiliated Association situated within their areas, on application, for the use of members of the Affiliated Association, a limited

- number of cards of admission to Section Meetings that are not restricted to Members of the Institution only, as may be found practicable, having regard to the available accommodation.
9. If considered of sufficient merit and interest, Papers read before meetings of Affiliated Associations, may be summarised for publication in THE JOURNAL of the Institution, where so arranged.
  10. Lists of fixtures and other items of interest to Affiliated Associations may be published in THE BULLETIN of the Institution, if so desired.
  11. Affiliated Associations will be supplied with full information regarding the Institution's Examination in Production Engineering, including copies of the Syllabus and Rules of the Examination, and particulars of the Courses of Instruction in Technical Colleges leading up to the Examination.
  12. The Council of the Institution will extend to Affiliated Associations such facilities as may from time to time be found feasible and of mutual advantage, and will seek to promote such co-ordination and co-operation between them and the Institution as may be found possible in the interests of Engineering Production.

## RULES AND SYLLABUS OF THE EXAMINATION FOR GRADUATE MEMBERSHIP OF THE INSTITUTION.

(Copies of the Rules and Syllabus can be obtained in pamphlet form on application to the Head Office of the Institution.)

### Objects of the Institution.

Among the objects for which the Institution is established are :—

- “ (a) To promote the science and practice and raise the status of engineering as applied to production; and to initiate and carry through any scheme or to organise any movement likely to be useful to the members of the Institution and to the community at large in relation thereto.
- (b) To hold meetings of the Institution for reading and discussing communications bearing upon engineering as applied to the matters enumerated in paragraph (a), or the application thereof, or upon subjects relating thereto.
- (c) To enable engineers to correspond, and to facilitate the interchange of ideas respecting improvements in the various branches of the practice of engineering as applied to production, and the publication and communication of information on such subjects to the members.
- (d) To establish scholarships, organise lectures, hold examinations, to grant premiums and prizes for papers and essays, and by any other similar means to enlarge the knowledge and improve the practice of engineering as applied to production.”

### Qualifications for Graduate Membership.

As defined in the Articles of Association the qualifications for Graduate Membership are :—

“ Graduates shall be persons, not under \*eighteen years of age, who can show evidence that they are receiving practical training in engineering production, or who otherwise satisfy the Council that there are special circumstances which, in the opinion of the Council, entitle them to admission.

Graduates may not continue as such if they cease to follow such professional calling in production engineering, nor in any case beyond the age of twenty-five. They may, however, on reaching

\*It is proposed to alter this to twenty.

this age be transferred, at the discretion of the Council, to the class of Associate Members."

The Annual Subscription for each Graduate is £1. On admission to the Institution Graduates may be required to pay an entrance fee, the amount of which shall be determined by the Council from time to time. At present, and until further notice, no entrance fee is charged.

Unless exempted by reason of having passed an approved examination of equal standard, only those who have passed the Institution Examination will be admitted to the Institution as Graduates.

#### **Award of Free Graduate Membership.**

The Council of the Institution will award Free Graduate Membership each year to those candidates who attain the five highest places in the Examination for Graduate Membership.

#### **Examination Conditions.**

Examinations will be held each year on the Saturday following Easter Sunday, in London, Glasgow, Birmingham, Manchester, and Bristol, and also at any approved University, Technical Institution or Works School elsewhere as may be required. Where less than five candidates enter at any centre for the examination, a local fee, additional to the ordinary examination fee of 10/-, may be charged.

Candidates are required to fill up the prescribed Form of Application for Graduate Membership (which can be obtained on request from the Head Office of the Institution, or from the Hon. Secretary of any Section of the Institution) and to send the Form, together with the examination fee of 10/- to the General Secretary, not later than 31st December. Where permission to sit for the examination is not given, the examination fee will be returned.

The Examination will be divided into four sections. Work on the first section—an Essay—will be performed at home and must be submitted not later than 28th February, whilst the remaining sections will be covered at an examination centre.

The examination will be of four-and-a-half hours duration, with an interval of one-quarter-of-an-hour, from 2.30 to 7.15 p.m., but candidates must present themselves not later than 2.15 p.m. at the place of examination.

Candidates must provide themselves with drawing instruments, scales, and set squares at examinations during which they may be required. Four-figure Logarithmic Tables, squared paper and drawing paper will be provided by the Institution. No other books or instruments may be carried into the examination room. Slide Rule calculations will be accepted throughout.

The list of successful candidates will be printed and posted to each candidate between one and two months after the examination. No other examination certificate will be issued.

## SYLLABUS.

The following Syllabus for each of the four sections of the examination is given to indicate the lines of study recommended to candidates, and is not intended to limit their interests but to direct it in desirable lines.

Specimen Examination Papers are printed elsewhere in this pamphlet. Only an elementary knowledge of the subjects is expected but the questions should not be beyond the capabilities of those who have taken an inquiring interest in their chosen profession, although their experience is of necessity limited.

In evaluating the candidate's work, the examiners will be guided rather by the practical knowledge and interest shown than by an academic reproduction of text-book information.

The four Papers of the Institution Examination are intended to test the candidate in those special branches which are of peculiar importance in Production Engineering. It should be understood that these are supplementary to the General Test embodied in the Application Form for Graduate Membership which will provide evidence of the extent of the candidate's acquaintanceship with the basic sciences of Engineering.

The Council of the Institution feel that although one of the major problems of Production Engineering is that of the human factor involved in the relations between Capital, Management, and Labour, too little attention has been given to this important subject in the Curriculae of Technical Schools. In the Paper on Works Organisation and Practice, therefore, some questions will be framed not only to reveal the candidates' attitude towards their fellow-workmen, but to discover their mental attitude towards Industry in general and Production Engineering in particular.

### First Essay.

Two Essays are required, one to be done at home, the other to be done during the examination. Candidates whose Application Form has been accepted will be required to submit an Essay of from 1,000 to 1,500 words on a Production Subject, within four weeks of the despatch of such notification. A list of Subjects will be supplied. Works of reference may be consulted by candidates, the titles of such works to be stated. The Essay must be accompanied by a Declaration that, subject to the consultation of works of reference, it is the unaided work of the candidate.

**Works Organisation and Practice.**Time  $2\frac{1}{2}$  hours. Maximum Marks, 150.**Part 1.**

Forms of Organisation and their uses.

Scientific Management and its application.

Departmental Organisation.

The Storing, Handling, and Movement of raw, part-finished, and completed materials.

Considerations affecting the construction of a works in respect of locality, power, heating, lighting, water, and transport services.

**Part 2.**

Workshop Drawings. Correctly dimensioned free-hand sketches and the criticisms of designs with a view to easier production whilst retaining the designer's intentions.

Limit Systems.

Machine Tools and their Uses.

The design of cutting edges.

Feeds and Speeds.

The planning and sequence of operations.

The influence of quantities upon methods.

Applications of Jigs and Tools.

Interval of one-quarter-of-an-hour.

**Second Essay.**Time  $\frac{1}{2}$  hour. Maximum Marks, 50.

There will be no interval between this and the next part of the examination, but the Essays will be taken up at the end of the time allowed for them.

**Elementary Economics.**Time  $1\frac{1}{2}$  hours. Maximum Marks, 100.

Elementary Economics and its applications, e.g., Wealth,

Land, Capital, Turnover of Capital, Profit Margins, etc.

The influence on industry of Home Office requirements.

Employers' Federation and Trade Union Regulations.

Payment by Results, Profit-Sharing, Co-Partnership, and other systems to encourage the worker to increase net profits.

Methods of (a) Estimating Costs.

(b) Building up Costs.

(c) Distribution of Overhead Charges.

Control of Purchases.

Relation of Sales Department to Production.

**Forms of Application.**

Intending candidates should apply to the General Secretary to

the Institution, or to the Hon. Secretary to any Section of the Institution, for the necessary Forms of Application for Graduate Membership.

#### **Exemption from Graduate Membership Examination.**

Candidates who have passed Section C of the Associate Membership Examination of the Institution of Mechanical Engineers, or any approved examination of equal standard, will be exempt from this examination.

### **SPECIMEN EXAMINATION PAPERS.**

#### **Works Organisation and Practice.**

Time allowed,  $2\frac{1}{2}$  hours. Maximum Marks, 150.

*Candidates are required to answer Questions 1 and 2 in Part 1 of this Paper and Question 8 in Part 2. In addition, they are expected to answer two other questions, which may be selected from either Part 1 or Part 2.*

#### **Part 1.**

- \*(1) Show in diagrammatic form the organisation in a large Engineering Works, and indicate the direction of flow of information. Explain the function of each chief official. (36.)
- \*(2) (a) Apart from the injury to the individual, what is the effect of an accident in the works ?
- (b) Design a form which your examiners can use to compare the relative values of the answers to the questions in this Paper submitted by candidates named Smith, Brown, Jones, and Robinson.
- (c) Assume that there have been errors in rate-fixing on piece-work jobs. State how you would deal with a case where too much time had been allowed, and with another case where the machine-shop hand is unable to make "ordinary time." (36.)
- (3) Is an inspector necessary ? Give reasons. (21.)
- (4) Plan a sequence of departments and state the chief points in building construction you would demand. (21.)
- (5) What are the duties of a Storekeeper ? (21.)
- (6) State briefly your knowledge of any system of limits for Cylindrical Fits. (21.)
- (7) Describe a gravity conveyor and indicate your knowledge of its application. (21.)

#### **Part 2.**

- \*(8) Study the printed drawing. Make a free-hand sketch approximately half-scale, and make any corrections you

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\*Compulsory questions.

think to be necessary. Your sketch should also show any alterations which you think would make for easier production. Give reasons for your corrections or alterations. (36.)

- (9) Sketch and describe a H.S.S. twist drill for cutting mild steel. What factors are considered when fixing speeds and feeds of twist drills ? (21.)
- (10) Does accuracy cheapen production ? Give reasons. (21.)
- (11) Make a dimensioned sketch of one tooth of a milling cutter to be used for machining a groove 1-in. wide in Cast Iron. (21.)
- (12) The article illustrated by the sketch given in Question 8 calls for several machining operations. Describe them in their proper sequence. (21.)

#### **Essay and Elementary Economics.**

Part 1. Essay on set subject. Time allowed :  $\frac{1}{2}$  hour. (50.)

Part 2. Elementary Economics. Time allowed :  $1\frac{1}{2}$  hours.  
Maximum Marks : 100.

*Candidates should attempt to answer five questions. Each answer will have a maximum value of 20 marks.*

- (1) Explain briefly the scope of Economics as the Science of wealth.
  - (2) Give the essence of any Home Office regulation affecting a machine-shop.
  - (3) Name five items of overhead charges and state which are fixed and which are fluctuating.
  - (4) If you are required to order an electric motor what information would you give ?
  - (5) Write an explanatory note on the agents of production.
  - (6) What information would you require in order to estimate the cost of production of the article illustrated in Question 7 in the Works Organisation and Practice Paper ?
  - (7) How can a Sales Manager assist the Production Engineer ?
  - (8) Assuming a constant demand for a product, state why it is sometimes better to buy raw material at the rate it is consumed rather than take advantage of a temporary low price ?
  - (9) How can a firm pay a 25 per cent. dividend to its Shareholders when it only makes 2 per cent. on its products ?
  - (10) What are the pros. and cons. of Profit Sharing ?
  - (11) What in your opinion is the best method of Payment by Results ? Give reasons.
  - (12) Name the three main divisions of a producing organisation.
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